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THE

ONTARIO WATER RESOURCES

COMMISSION

WATER QUALITY EVALUATION

# of the

LOWER SPANISH RIVER

1967

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Water quality evaluation of the
Lower Spanish river / Conroy, N.

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WATER QUALITY EVALUATION

# of the

LOWER SPANISH RIVER

by
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and
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Biology Branch
Division of Laboratories

THE ONTARIO WATER RESOURCES COMMISSION

SUMMARY AND CONCLUSIONS

The Spanish River from Espanola to Brennan Harbour is affected by waste discharges from the kraft pulp mill at Espanola. The severity of the pollution is reflected by the disruption of the bottom fauna community, the peculiar taste of fish, the odour of the water, and by the high fibre content of the water and the bottom sediments. The results of biological data obtained in 1967 indicate that further impairment has occurred since 1951.

The potential multiple use of the 35 miles of river is not realized because of pollution from Brown Forest Industries and to a lesser extent from the towns of Espanola, Massey and possibly Webbwood. The peculiar odour of the water limits its use as a domestic water supply and eliminates its value for swimming and associated recreation. The objectionable flavour of fish flesh from the river and the adjacent portion of the North Channel imposes an economic limitation on the commercial fisheries of the area and limits the usefulness of the river for sports fishing. Fibre content of the river and the disruption of the bottom fauna community, as well as the adverse changes in water quality, places the fish population of the river in jeopardy. The passage of floating fibre mats presents another limitation on the recreational use and aesthetic enjoyment of the river. An entire lack of riparian activity was noted during the August - November cruises made in conjunction with the 1967 biological survey (14 days). If the objectives of the Ontario Water Resources Commission are to be satisfied and the requirements for the multiple use of our waters are to be met, an improvement in the quality of the discharge from the pulp and paper mill at Espanola is necessary.

The results of limited bacteriological sampling to evaluate municipal waste sources indicated impairment of water quality below the standards for acceptable recreational water use. While the effect of organic municipal wastes in contributing to alterations in bottom invertebrate life and in impairing the aesthetic quality of the river is masked by the greater volume of paper mill wastes, its significance should not be overlooked.

RECOMMENDATIONS

1. A planned program establishing an acceptable schedule of waste improvement should be developed by Brown Forest Industries in co-operation with the OWRC and the implementation of proper waste control measures should proceed without delay to achieve the necessary water quality goals.

2. In particular, efforts should be made to isolate and remove objectionable taste - and odour - producing components of the waste and to substantially reduce fibre losses.

3. Improved treatment should be provided at Espanola to promote

rehabilitation of the Spanish River as quickly as possible.

4. A collector system and waste treatment facility should be provided at Massey.

INTRODUCTION

The wastes from the pulp and paper industry at Espanola, Ontario, have been the source of much attention for some time. As early as 1947 surveys were conducted by the Ontario Department of Lands and Forests to investigate complaints of fish kills and the foul taste of fish flesh (Tranmer and Whitfield, 1950). Commercial fishermen have complained about the rejection of fish shipped to market because of the tainting of fish flesh and subsequent loss of income. One of the more thorough investigations was outlined in 1952 by J. R. Dymond and A. V. Delaporte in a report entitled Pollution of the Spanish River.

The results of the surveys conducted on the Spanish River prior to 1950 led to court proceedings in 1951. An act of the provincial legislature was passed, referred to as the K.V.P. Act, the purpose of which was to nullify an injunction which had been pressed against the Kalamazoo Vegetable Parchment Company (K.V.P.), for the purpose of establishing essential waste control requirements. This legislation was passed in consideration of the importance of this particular industry to the economy of the Espanola area. The history of pulp and paper activity at Espanola dates to the early 1900's. Prior to the acquisition of the Espanola mill by K. V. P. in 1945, the site had been closed to operation for 10 years. At present the mill is operated by Brown Forest Industries.

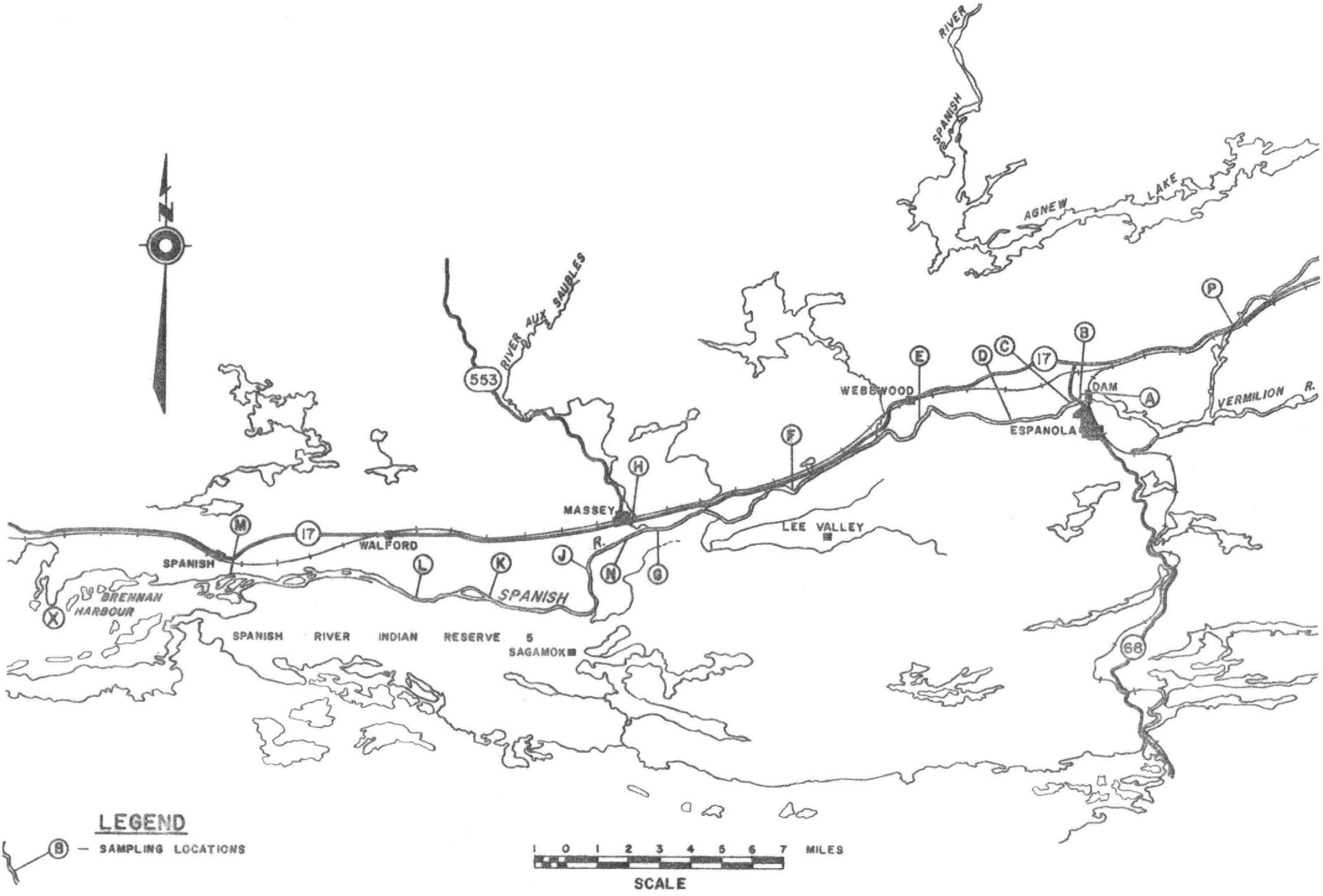
Treated municipal wastes are discharged to the Spanish River at Espanola and domestic pollution from the smaller centres of Webbwood and Massey could have some effect on the river. A survey was undertaken in September, 1967, to up-date knowledge of the conditions in the lower Spanish River and to provide a foundation for waste effluent controls in keeping with the present water quality objectives of the Commission. The survey included evaluation of the presence of malodorous substances in the water and relationships with earlier studies of the tainting of fish flesh (1965), assessment of fibre discharge and deposition, and of particular emphasis, the sampling and evaluation of plant and animal communities. Supporting data concerning the chemical quality of the water and bottom sediments of the lower Spanish River were obtained. Information on bacteriological quality collected by personnel of the Division of Sanitary Engineering in October, 1967 is included in this report.

DESCRIPTION OF THE STUDY AREA

Figure 1 shows the general features of the lower Spanish River drainage basin. It indicates the sampling ranges selected for the 1951 survey by Dymond and Delaporte which were used again during this survey. A description of each of the sampling ranges is provided in Table I of the Appendix.

The flow at Espanola varies from 1,520 cubic feet per second (cfs) in the summer low-flow period, to 16,350 cfs

FIGURE I – SAMPLING LOCATIONS ON LOWER SPANISH RIVER DRAINAGE BASIN



during the height of the spring runoff. The average flow is 4,550 cfs (Dymond and Delaporte 1951).

Three sub-watersheds discharge to the lower Spanish River within the study area. The Vermilion River enters the Spanish River approximately 5 miles east of Espanola. Gough Creek enters from a northerly direction at a point west of Webbwood and the aux Sables River drains southward and enters the Spanish River at the Town of Massey.

The Spanish River Basin is largely cut from sand-filled valleys in which the banks of the river rise to 60 feet above the water. Occasional outcrops of bedrock occur along the watercourse. Much of the river bottom above Massey is an eroding substrate, as indicated by the lack of organic matter at many sampling ranges.

The largest potential source of pollution is the pulp and paper mill at Espanola. However, effluent from a primary sewage treatment plant, having an estimated mean flow of 270,000 gallons per day, enters the river at Espanola. Limited pollution from septic tank drainage reaches the Spanish River from Massey and Webbwood. The river is used as a supply of water by a small portion of the population in the settlement of Spanish.

The Spanish River is easily navigable from its mouth to the dam at Espanola; however, very little use is made of the river for recreational purposes. The tourist establishments at Spanish direct their sports fishing clientele to the North Channel, away from the mouth of the river.

Commercial fishing is undertaken in the North Channel but fishing regulations prohibit netting close to the mouth of the river.

BIOLOGICAL EVALUATION OF WATER QUALITY

Biological evaluations are usually based on the composition of the total macroinvertebrate population (usually aquatic insects) and the presence and relative abundance of 'clean water' and 'pollution-tolerant' forms, as well as the diversity and relative abundance of fish species. Clean waters are usually characterized by a wide diversity of invertebrate and fish species and no marked numerical predominance of any one type. On the other hand, the community in organically polluted waters is characterized by large numbers of a reduced number of species, the survivors being capable of withstanding low levels of dissolved oxygen. Toxic pollution may have an entirely inhibitory effect on the production of aquatic life.

The physical accumulation of organic matter in a river or lake may affect the benthic community. In the specific case of pulp and paper mills with relatively high fibre losses, the bottom fauna in areas of fibre accumulation and heavy waste loading is comprised largely or wholly of pollution-tolerant sludgeworms. Moderately heavy loading usually results in a community composed of tolerant sludgeworms and bloodworms (midge larvae). Domestic sewage loading has a similar effect on the macroinvertebrate bottom fauna community.

Suspended fibre affects the delicate gills of many of the invertebrate forms and fish. Smith, Kramer and Oseid (1966) report that suspended fibre reduces the scope of activity of fingerling walleyes and inflicts permanent damage to mature walleyes.

METHODS

Odour of River Water

In June, 1965, water was collected from ranges P, (above Espanola), B, below Espanola, G, (at Massey) and M, (Spanish Harbour) for threshold odour determinations. Results of these analyses have been reported previously (Swabey, 1965).

Similar samples were collected in October, 1967, from ranges P, B, E, G, N, L, and M, which were analyzed within 24 hours. The method employed in both years was identical and involved making up a dilution series for each sample and having a test panel report on the presence or absence of a perceptible odour. As a check on the panelists, control samples of odour-free water were interspersed amongst the samples from the Spanish River. Testing was accomplished utilizing carefully controlled laboratory conditions, free of any odourous interference. The results are reported as geometric mean threshold odour (GMTO). The GMTO represents the number of dilutions at which the odour will be just barely perceptible by the majority of the participants in the test.

Taste of Fish Flesh

Walleye or yellow pickerel (*Stizostedion vitreum*) were collected from the Spanish River during the 1950-51 survey and were utilized in flavour evaluation tests by the Fisheries Research Board of Canada at Halifax, Nova Scotia. Control fish for this testing were from Lake Mindemoya, Manitoulin Island.

The same fish species were used in a similar test conducted by the Ontario Water Resources Commission in 1965 (Swabey, 1965). Controls for this testing were from Lake Onaping. The test fish were taken from ranges M and X (Figure 1).

Additional information regarding the objectionable taste of fish was obtained through personal communication with commercial fishermen who are licensed to net fish from the North Channel adjacent to the mouth of the Spanish River.

Fibre Content

To determine the extent of fibre losses from the mill, water samples collected at stations P, B and E were analyzed for the organic fraction of suspended solids. This 'loss of weight on ignition' of suspended solids is the method indicated by the Department of Health of the state of Wisconsin as being appropriate to indicate the approximate fibre content of water, although more correctly, it is a measure of the organic portion of all suspended matter.

One litre of sample was filtered through Watman 40 filter paper with the aid of vacuum. The weight of the suspended solids on the filter paper was calculated after alternate washing with distilled water anddilute hydrochloric acid and drying at 103°C for eight hours. The filter paper and the suspended matter were placed in a muffle furnace at 600°C for one hour. From this, the loss on ignition or organic fraction of suspended solids was calculated.

Bottom accumulations of fibre were determined by examining the sediments collected with a Petersen dredge. The sediments were classified according to the percentage by volume of fibre, bark, fine sand and mud, and coarse sand, gravel or rock.

Observations were made on the abundance and distribution of fibre mats in the river during cruises completed during August and November.

Biological Evaluation of the River

A bottom sample was collected from three stations at each range, one from the littoral zone near each bank and one from midstream. Within the text, reference by a letter denoting the range suffixed by the numeral '1' represents a sample taken close to the north bank, suffix '2' is a sample from midstream and suffix '3' denotes a sample collected from the bottom near the south bank.

A Petersen dredge was used to collect the samples of bottom sediments. The dredge is a clam-like sampler which is lowered to the bottom from a boat with the jaws open. A self-releasing pawl allows the dredge to close and retain the bottom sediments in an area of 96 square inches. The depth to which the dredge penetrates depends on the nature of the bottom sediments. The bottom materials were placed in a fine mesh screen box, classified and sieved. The sediments which remained in the screen were washed into bottles and transported to the field laboratory in Elliot Lake. The bottom fauna picked from the sediments were preserved in alcohol for subsequent identification.

RESULTS

Odour of Spanish River Water

Table 1 compares the Geometric Mean Threshold Odour for 1947, 1965 and 1967 from Espanola to Spanish.

Table 1. Geometric Mean Threshold Odour (GMTO).

Station	P	H	B	E	G	N	L	M
Mileage (from Espanola)	-7		0	5	16	16+	30	35
GMTO May, 1947	1.6		90.0	7			8	7
June, 1965	2.3		166.8		57.0			29.7
Oct., 1967	8.2	1.9	57.3	33.8		30.1	26.3	34.4

The suggested upper limit for threshold odour is 4, (Objectives for Water Quality Control in Ontario.). A GMTO of 8.2 was found in 1967 at P, at the control range. This was considerably higher than the value of 2.3 during the 1965 period. Some variability is not unusual since both of these samples were grab samples and were taken at different times of the year. The threshold odour level (8.2) was unusually high at range P in 1967 for some unexplained reason. Below Espanola, the value increased to 166 in 1965 and 57 in 1967, at range B. A slow decrease was apparent to range L. In 1967, however, the values at range M were again higher. This was probably due to the release of odour-producing components from the settling of suspended fibre at the junction of the river and the North Channel. In all years the water downstream as far as Spanish was malodourous and required considerable dilution before the objectionable odour was eliminated.

Taste of Fish Flesh

The character of the river water below Espanola was reflected in the taste of yellow pickerel taken from the river in 1965. The samples showed that test fish from the Spanish River and the North Channel adjacent to the mouth of the river had an objectionable flavour. Samples analyzed 14 years previous, (Dymond and Delaporte, op. cit.) revealed that pickerel from the Spanish River had an objectionable taste, but little odour. The grade established was only 39% and was compared to a grade of 63% for control fish of the same species from Lake Mindemoya. The objectionable taste was reported to be suggestive of indol and protein decomposition.

Additional information relevant to the disagreeable taste of fish flesh was provided by commercial fishermen who fish the North Channel in the vicinity of range X. Receipts from fish buyers submitted to the OWRC by commercial fishermen indicate a loss of revenue owing to the tainting problem. One buyer of a lot of yellow pickerel urges - "yellows (walleyes) had a kerosene smell and taste and we dumped them. Please check on yellows before shipping". The buyer of another lot states "ran into a little trouble with yellows account of same being tainted". The fishermen receive refusals on some lots of fish and consistently receive a reduced price for their fish which are caught off the mouth of the Spanish River and as far away as Manitoulin Island. Pickerel caught in other areas of the North Channel are worth from 45 to 60 cents per pound, while fish from Brennan Harbour bring only 30 to 35 cents per pound on the same market. The loss in revenue for the commercial fishermen is from 100 to 300 dollars per ton for pickerel alone. In addition, considerable loss occurs from the sale of other species.

One of the components of the paper mill discharge which might contribute to imparting objectionable taste in fish is the group of phenolic wastes. Table II of the Appendix gives the levels of phenols for the river from a sample collected in November, 1967. Objectives for Water Quality in the Province of Ontario suggests a level of 2 parts per billion (ppb) as the acceptable levels of phenolic compounds. The levels of phenols from stations B to M are higher than the recommended limit. It is recognized that the test for phenols may include the tannins and lignins associated with the decomposition of many different organic materials that might be present in these waters.

Fibre Content

The fibre losses from the pulp and paper mill at Espanola are considerable, as indicated in Table 2.

Table 2. Fibre Content of Spanish River Surface Water, January,1968.

Range	Total solids (ppm)	Susp. solids (ppm)	Loss on Ignition of Susp. solids (ppm)	Fibre content* Ton/day
P	35	2	.1	-
B	360	52	18	167
E	96	14	5	33

* Based on a flow of 2000 cubic feet per second or 1292 million gallons per day.

The loss on ignition of 18 ppm obtained for surface water collections taken in January, 1968, represents a passage of approximately 170 tons per day of fibre at range B. This value is probably somewhat in error since suspended matter from the mill has not been distributed uniformly throughout the water by range B. An Industrial Waste Survey (Macey 1967) revealed a suspended solids loading of 57 tons per day in the effluent.

The mill is fitted with only inplant controls, therefore virtually all the losses measured in the effluent reach the river. By range E, distribution would be uniform and the losses are shown to be 33 tons per day. The fibre or suspended organic matter at range P was less than 0.1 ppm and therefore a calculation of the tonnage per day passing this range was not made. In the fall of 1951, it was shown that the amount of fibre passing range D amounted to seven or eight tons per day; however in April 1951, a fibre content of 97 tons/day was found at range E.

Considerable quantities of fibre were dredged from the river bottom at certain stations. These data appear in Table III of the Appendix. A positive relationship existed between bottom accumulations of fibre and high population levels of pollution-tolerant sludgeworms (see section on biological results, including Figure 2). The observations on the abundance and distribution of fibre mats indicated that a considerable amount of the accumulated fibre is periodically carried downstream. During cruises in August and again in October, fibre mats were observed between ranges E and M, with a maximum number observed between ranges F and N. Mats were visible at all times between these ranges and up to 10 mats were sighted in 100-yard sections of river at one time. The mats varied in size from two to five feet in diameter.

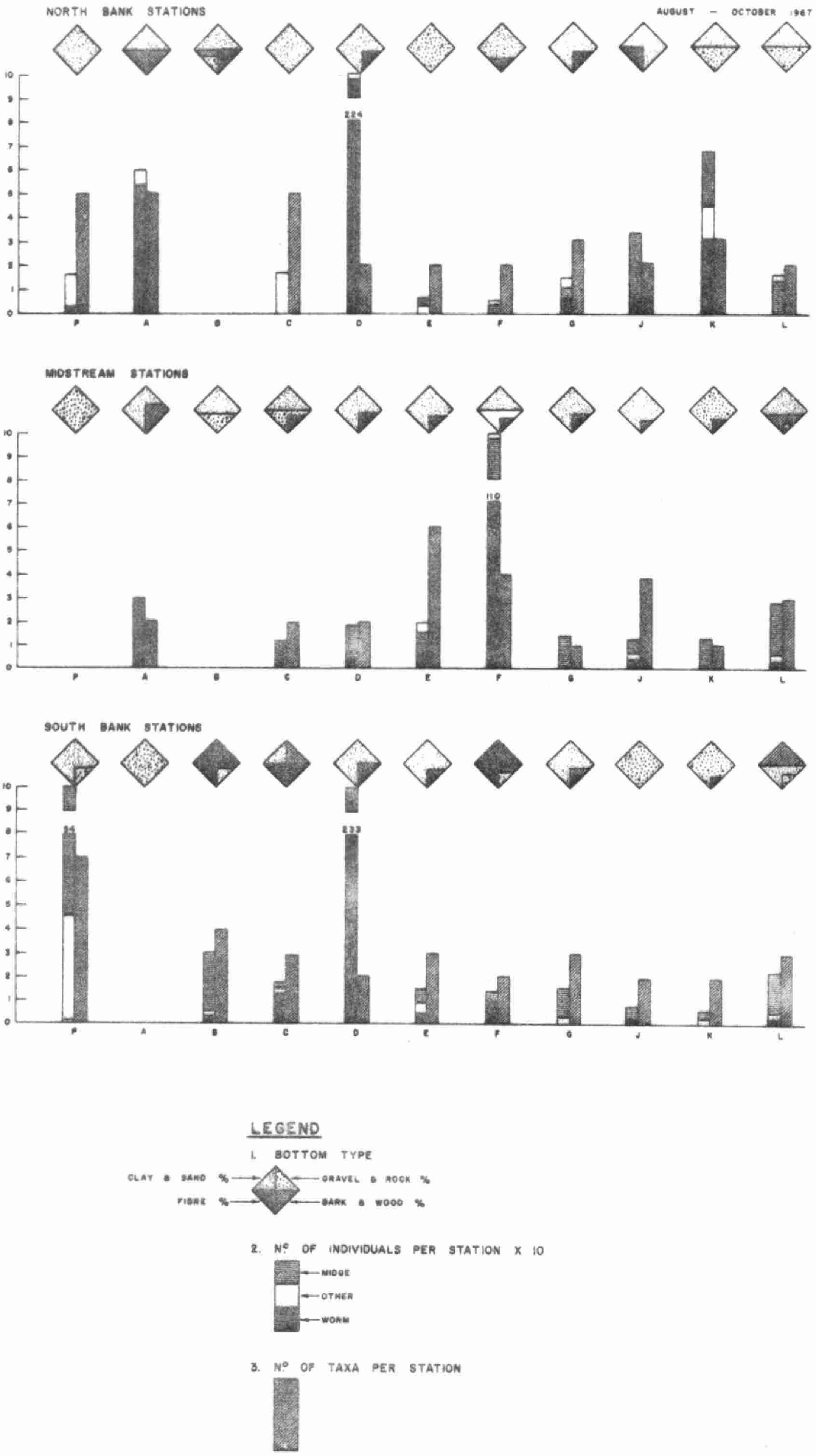
Biological Evaluation of Pollution

The results of the bottom fauna collections are provided in Table IV of the Appendix and are presented graphically in Figure 2 of this section (A, B, and C). Bottom sediment classification from Table III of the Appendix appears in this same figure. The samples collected were equal to 2/3 square foot of bottom. The values in Table IV and Figure 2 are corrected to equal 1 square foot of bottom. Only whole number relationships are shown.

The river is markedly variable with respect to flow. Areas of fast, relatively shallow water form zones of eroding substrate and areas of deeper, slow moving water form zones of accumulation. These variations in flow produced variations in the bottom fauna community even from one station to another in the same range.

The impact of waste discharge on the river becomes apparent as the macroinvertebrate bottom fauna community is examined above and below Espanola. The control stations at range P supported a benthic community indicative of clean water. The bottom of the river in midstream at range P was highly eroded. Five taxa were screened from the sediments near the north bank and seven taxa from the south bank. Included in the taxa were individuals of the pollution-sensitive groups. Immature caddisflies, mayflies and fishflies, amphipods, snails and clams were found, as were large numbers of midge larvae which are the immature stage of a large family of true flies.

FIGURE 2 - BOTTOM TYPES AND BIOLOGICAL CONDITIONS OF THE SPANISH RIVER



Sludgeworms were present in low numbers (2 per square foot).

The bottom fauna community at range A, just above the dam, was affected by the presence and decay of bark accumulations. Near the north bank there were 23 sludgeworms per square foot, all of the pollution-tolerant genera Tubifex and Limnodrilus. The other dominant taxon was midge larvae. Immature caddisflies were present but were limited to 2 individuals per square foot, as were amphipods. The snails, clams, immature fishflies and mayflies found at range P were absent from the sediments examined. In mid-stream, the community was even more limited since only sludgeworms and midges were present. A sample was not obtained near the south bank because of the rocky nature of the bottom.

Sampling at range B, directly downstream of the main source of waste discharge, indicated that the waste had a toxic effect on the biota. The sediments at B 1 and B 2 were void of macroinvertebrate life, while the sediments from the south bank (B 3) contained thirty individuals representing 4 taxa. Although midges dominated the sample, forms such as fishfly larvae were present. The more diverse community structure at this point may be explained by the fact that the station lay outside the main stream of the discharge and because of the influence of runoff water entering the river directly south of the sampling station.

The bottom fauna community at range C was depressed suggesting an inhibitory effect from fibre deposition and the municipal wastes discharge 100 yards upstream. In mid-stream, a community comprised only of sludgeworms and midges was present. A slightly larger population of worms existed at C3, close to the south bank. An area near the north bank, associated with a gulley collecting runoff water, had a more diverse macroinvertebrate community. The environment was stratified by the presence of submerged sticks on the relatively steep bank which increased the diversity of the habitat. The bottom fauna community was typical of an unpolluted environment and certainly atypical of the river at this point.

At range D, two miles downstream of Espanola, only two taxa were represented and sludgeworms reached a maximum of 233 per square foot. All but 12 of these worms were of the same species, Limnodrilus hoffmeisteri, a species indicative of high organic enrichment. An eroding substrate in mid-stream favoured the midge larvae. However, only 2 taxa (midges and worms) were screened from this station.

The macroinvertebrate bottom fauna community at range E, upstream of Webbwood, suggests a slight improvement in the quality of the river. The water in this region is relatively swift and therefore only slight fibre accumulations were found. Sludgeworms and midge larvae still dominated; however, the numbers were lower than in the previous range. Snails, mites and other dipteran fly larvae were present in reduced numbers.

The slight improvement suggested at range E was not evident at range F. The bottom fauna community was dominated by the sludgeworm, Limnodrilus hoffmeisteri and midge larvae in excess of 75 and 25 individuals per square foot, respectively. The difference noted relative to range E is not attributable to waste input from Webbwood but rather to reduction in flow and fibre deposition.

The first concrete evidence of improvement occurred at range G, upstream from the confluence of the aux Sables and Spanish rivers and 16 miles downstream of Espanola. The community was still dominated by worms and midges but other taxa were present, including immature fishflies. The worms were reduced to 5 per square foot on the north bank and midges were present at all stations, reaching a maximum of 15 per square foot in midstream. The bottom fauna at range G was influenced by backwater from the confluence of the aux Sauble and Spanish rivers.

The water quality of the aux Saubles River was satisfactory as demonstrated by the bottom fauna which were collected at range H. No worms were present and pollution-intolerant caddisflies were abundant.

Range J, 4 miles below Massey, showed moderate impairment. The bottom fauna community was represented by only two taxa, again sludgeworms and midge larvae. The number of worms had decreased while the midge larvae had become more abundant. The flow at range J is relatively swift and thus fibre accumulation was slight.

Moderate impairment was still indicated at range K. The substrate was of an accumulating nature and the number of worms present reached 30 per square foot on the north bank. Again, L. hoffmeisteri was the only species of worm present. Midges, too, were found in significant numbers. Some significance may be placed on the fact that snails were present at range K. Their presence indicates increased diversity of the community and thus suggests improvement. It is significant that snails were abundant above the mill at Espanola and were not found in significant numbers again until this range.

The final range, L, 30 miles below Espanola, showed moderate impairment, also. The macroinvertebrate bottom fauna community was represented by 3 taxa, none of which were indicative of clean water conditions.

Evaluations of bottom fauna communities along the lower Spanish River did not reveal any changes that could be directly related to organic deposition associated with municipal waste discharges. This is not surprising considering that the ratio of paper mill organic wastes to municipal organic wastes from Espanola, the largest municipality, is in the order of 500 to 1 (based on loadings of suspended solids). This is not to say that importance should not be attached to these sources of pollution which were evinced by the bacteriological results (see page 20).

The results of the biological survey carried out in 1951 and 1952 were remarkably similar to the results of this survey. A marked increase in the number of worms occurred in the vicinity of range E and slowly returned to normal or near normal by range L.

The general distribution of snails was the same throughout in 1951 and 1967. The other major group - midge larvae - also showed a general similarity. The distribution of clean water taxa was similar for both surveys between range P and range F. There was, however, a more diverse community between range F and range L in 1951. The increase in the number of caddisfly larvae at range F in 1951 was not shown in 1967. The same was true of the number of immature mayflies per station. In 1967, these two clean water taxa were virtually absent from the river below Espanola. The macroinvertebrate bottom fauna community did not return to the same complexity demonstrated in 1951 even thirty miles below Espanola.

Bacteriological Character of Spanish River Water

Table 3 shows the results of a single series of bacteriological samples collected by the Division of Sanitary Engineering during an assimilation study in October, 1967. The Commission's objective of 2400 coliforms per 100 ml was exceeded at all locations on the Spanish River with the exception of range G.

Table 3

Approximate range	Stations					
	C	E	F	G	H	N
Coliforms/100 ml	5000	8600	10,100	1145	110	28,000

These results suggest that some impairment of water quality was attributable to domestic waste inputs from the towns of Espanola, Massey and possibly Webbwood.

Chemical Analyses of Water and Bottom Sediments

Water Chemistry

Chemical analyses of water samples collected in November, 1966, are presented in Table II of the Appendix. Results at range P were indicative of clean water. The total solids were low at 42 ppm of which only 2 ppm were suspended, and the water was soft, containing 20 ppm calcium carbonate hardness.

Some of the more significant analyses from Table II of the Appendix are shown by means of graphs in Figures 3 and 4. The information relative to the line graphs is obviously discontinuous; however, to illustrate the trends in water quality from range to range, the data are considered to be continuous.

At range A, decomposition of the accumulations of bark and wood in the log holding areas had elevated the values of the chemical parameters of the water relative to

FIG. 3 — LINE GRAPH OF LEVELS OF SULPHATE, SODIUM AND CHLORIDES

NOVEMBER 1967

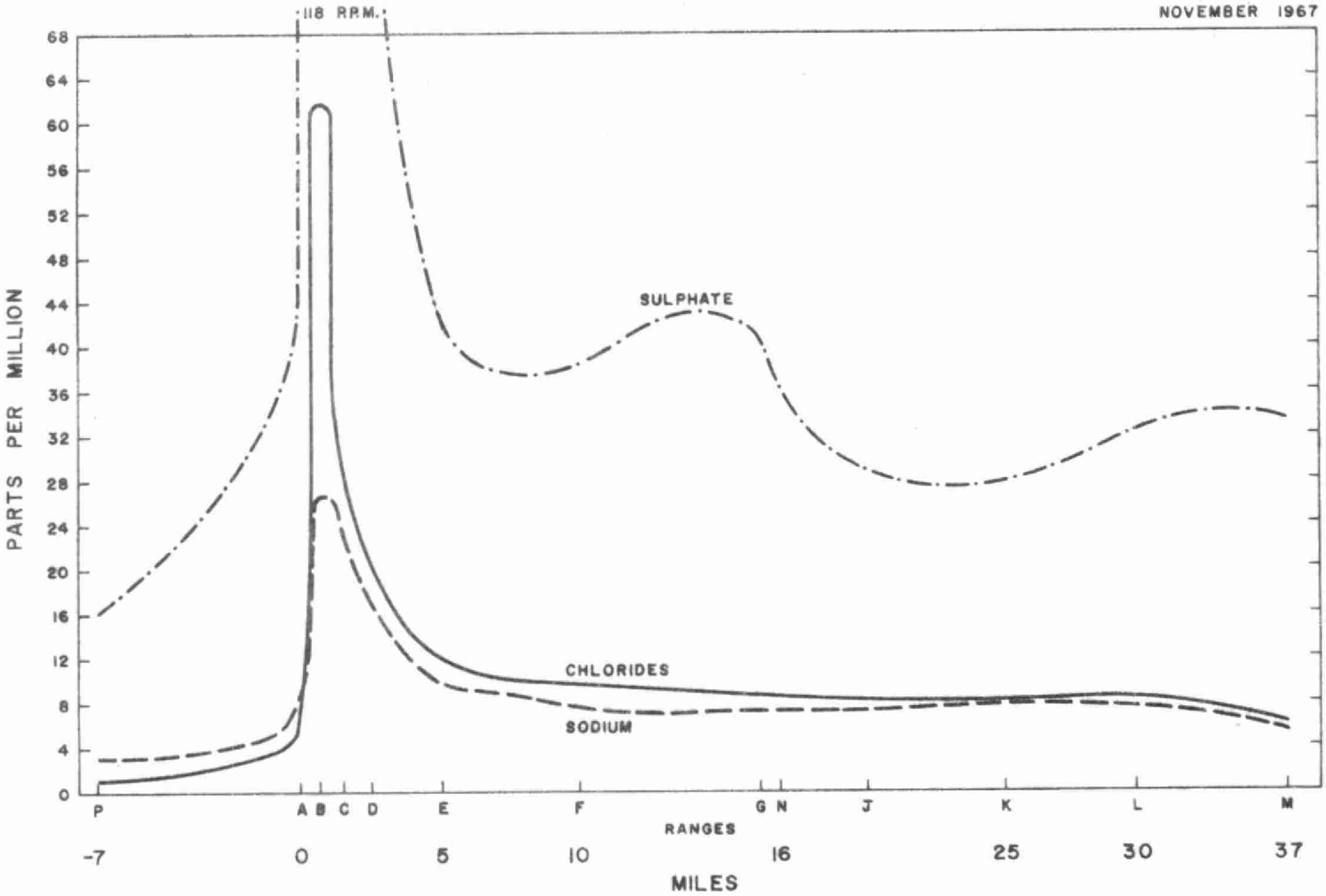
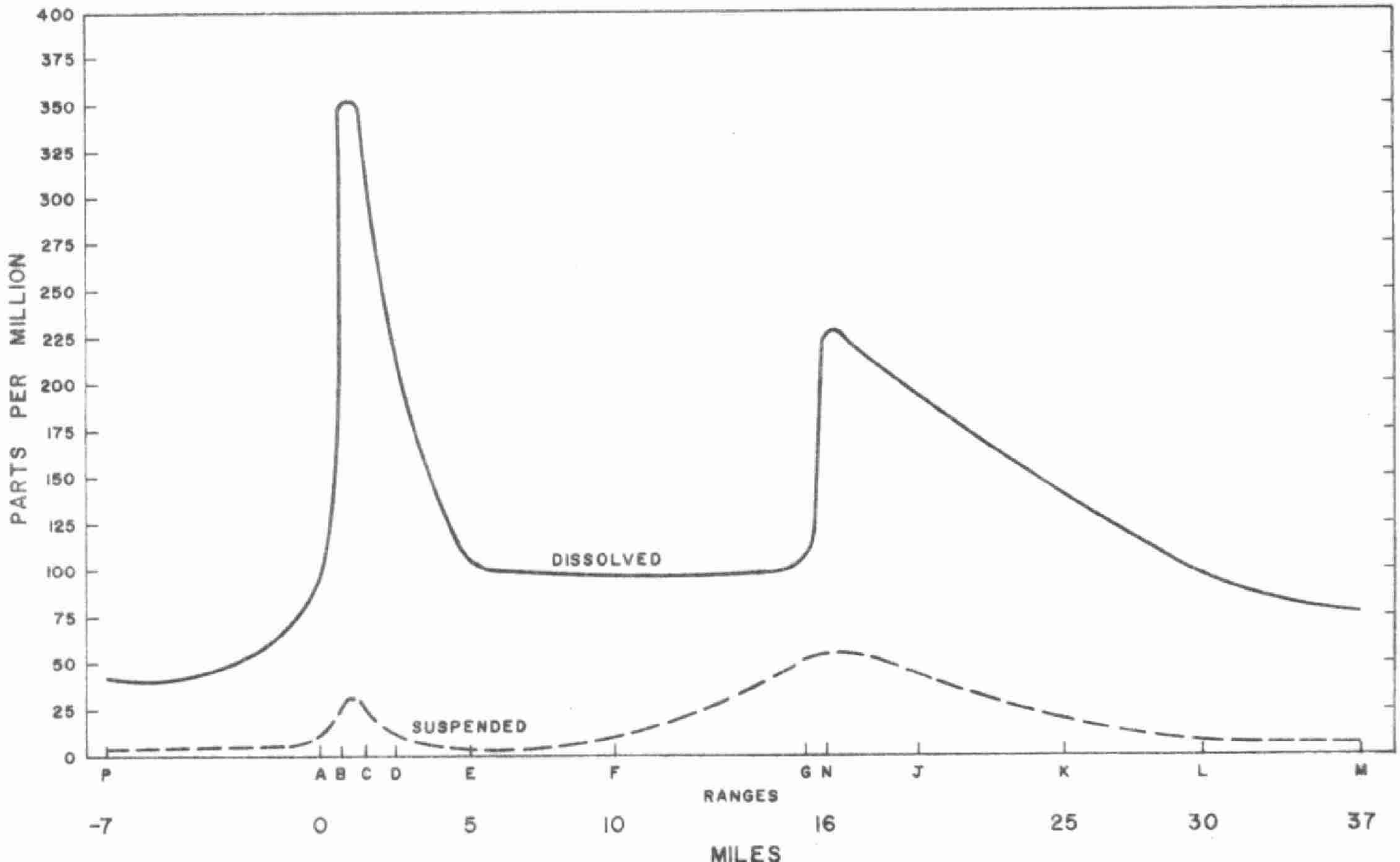


FIG. 4 — LINE GRAPH OF TOTAL AND SUSPENDED SOLIDS IN P.P.M.

NOVEMBER 1967



reference range P. The dissolved solids were doubled to 96 ppm while the suspended solids remained constant. Sulphates as ppm $SO_4^{=}$ were 2½ times higher than at range P. Because of the delay between sampling and analysis, the sulphate value is only indicative of oxidizable sulphide ions. A portion of the sulphites released by the decay of the bark and wood would have been oxidized during the delay to sulphate. Hardness showed a two-fold increase to 48 ppm.

Analyses of water samples collected from range B indicated gross changes in the chemical and physical characteristics of the water. Dissolved solids rose to 338 ppm or 700 per cent over the conditions at range P. Sulphates showed a change of the same magnitude. Suspended solids rose to 31 ppm or 15 times the value of either ranges P or A.

Physical and chemical analyses of surface water from range E revealed a reduction in most parameters over the corresponding levels from range B. Total solids were reduced by one-third to 108 ppm. Sulphates were reduced but were considerably higher than in the reference region (see Table II and Figures 3 and 4).

No appreciable change occurred in the chemical quality of the water between ranges E and G.

Bottom sediments

The chemical analyses of bottom sediments are provided in Table 3, below:

Table 3. Analyses of Organic Sediments from Spanish River - August and October, 1967.

Determinations	P 1	A 2	E 2	F 2	G 3	H 1	K 2
Phenols (ppb)	1500	8000	600	800	600	400	1500
Lignin as Tannic acid %	0.015	0.10	0.015	0.02	0.01	0.005	0.02
Total Kjeldahl nitrogen %	0.05	0.23	0.023	0.04	0.023	0.015	0.04
Calcium % carbonate as CO_3 %	0.79	1.14	0.89	1.01	0.77	0.66	1.06
Ether extract	0.022	0.14	0.018	0.04	0.006	trace	0.022

At range A, directly above the dam at Espanola, the bottom had been changed by accumulations of bark from the log holding areas. Phenols, lignin and ether extracts were higher than at any sampling range in the river. Analyses of the bottom sediments at range B indicated that little settling had occurred at this point. This is reasonable considering the relatively swift flow and incomplete mixing of the discharge. There was little difference in the character of the sediments between ranges E and K, except that the phenolic content increased at K because of the accumulation of fibre in that area.

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Report prepared by:	Report approved by:
N. Conroy, Biologist	C. F. Schenk, Supervisor Biology Branch

APPENDIX

Table I Description of sampling ranges on Spanish River .... (i)

Table II Chemical analyses of Spanish River water, November, 1966 (ii)

Table III Classification of Bottom Type at Sampling Stations (iii)

Table IV Bottom Fauna from the Spanish River, August and November, 1967 (iv)

Table I. Description of sampling ranges on Spanish River.

Range P, at the bridge on King's Highway 17 over the Spanish River is seven miles east of the town of Espanola. Range P was used as the first reference range. Range A, directly above the dam and pulp and paper mill, was also used as a reference station.

Range B is 100 yards below the control dam at Espanola and 25 yards below the emergence of the mill wastes into the river.
Range C is 3/4 mile below range B and 100 yards downstream from the outfall of the Espanola sewage treatment plant.
Range D is two miles below range B.
Range E is in the vicinity of the bridge over the Spanish River, east of Webbwood.
Range F is 11 miles below Espanola at Cameron Rapids.
Range G is 16 miles below range B and east of the confluence of the aux Saubles and Spanish Rivers at Massey.
Range H is not on the Spanish River but on the aux Saubles River, ½ mile from the mouth.
Range N is 100 yards below the confluence of the aux Saubles and Spanish River.
Range J is 20 miles below Range B. Samples were dredged from above Cole's Rapids.
Range K is 25 miles below Espanola at McKee's Rapids.
Range L is 30 miles below Range B.
Range M is the last station sampled. It is ¼-mile east of the town of Spanish
Range X is in the Brennan Harbour, three to five miles from the mouth of the river. Commercial fisheries operation are conducted in this range.

Table II. Chemical analyses of Spanish River water, November, 1967.

Test	P	A	B	E	G	N	L	M
Hardness as $CaCO_3$	20	48	59	50	8	52	48	44
Alkalinity as $CaCO_3$	14	16	19	19	18	20	18	16
Chloride	11	5	62	9	8	7	8	6
pH at Lab	7.6	6.6	6.6	7.1	7.5	7.4	6.9	7.2
Turbidity	3.3	3.3	2.4	4.0	4.0	4.0	3.6	3.8
Acidity as $CaCO_3$	4	4	20	4	2	2	6	6
Sodium as Na	3	6	27	9	7	7	7	5
Sulphate as $SO_4^{=}$	16	40	118	41	41	35	32	33
Calcium as Ca	14	13	16	14	14	13	13	12
Total Solids	42	98	388	108	112	287	94	78
Susp. solids	2	2	31	6	6	57	3	5
Diss. solids	40	96	357	102	106	225	91	73
Free ammonia	0.13	0.39	0.46	0.41	0.57	0.41	0.57	0.49
Total Kjeldahl	0.45	0.84	1.10	1.10	0.98	0.84	0.98	0.84
Nitrite	0.005	0.10	0.014	0.006	0.005	0.006	0.005	0.009
Nitrate	0.10	0.30	0.10	0.25	0.15	0.20	0.20	0.10
Phenols (ppb)	2	0	10	8	6	4	3	3
Iron	0.41		1.33	0.39	0.44	0.45	0.63	0.40
Fatty acids and soaps	0.0		0.0	0.0	0.0	0.0	0.0	0.0

Table III. Classification of Bottom Type at Sampling Stations

Station	% clay, fine sand	% rock and gravel	% fibre	% bark and wood
P 1	100			
P 2		100		
P 3	80	15		5
A 1	50			50
A 2	70			30
A 3		100		
B 1	60	10	20	10
B 2	60	40		
B 3	20		80	
C 1	100			
C 2	40	50	10	
C 3	50		25	25
D 1	80		20	
D 2	80		20	
D 3	75		25	
E 1		100		
E 2	80		10	10
E 3	80		10	10
F 1	80		10	10
F 2	55		10	35
F 3	10		80	10
G 1	80		20	
G 2	80		10	10
G 3	80		10	10
J 1	75			25
J 2	90			10
J 3		100		
K 1	50	50		
K 2		90	10	
K 3		90	10	
L 1	50	50		
L 2	60	10		30
L 3	40	10		50

Table IV. Bottom Fauna from the Spanish River, August and November, 1967.

	P			A			B		
Taxa	1	2	3	1	2	3	1	2	3
NEMATODES									
WORMS									
Tubifex	2			17	2				2
Limnodrilus				6	3				
Peloscolex									
SNAILS									
Campeloma	2		2						
Lymnaea	6		14						
Helisoma			3						
CLAMS									
Sphaeriidae	2		5	2					
AMPHIPODS									
Hyalella									
Gammarus									
ISOPODS									
Asellidae									
FISHFLIES									
Sialis	2		9						2
CADDISFLIES									
Psychomyiidae			8	2					
Hydropsychidae									
MAYFLIES									
Heptagenia	2		2						
Ephemerella									
MIDGES			54	21	23				24
OTHER FLIES									
Culicoides			6	2					2
Tabanus			2						
Dixidae									
Tipulidae									
MITES									
Acari									
Total taxa	5	0	7	5	2	0	0	0	4
Individuals	16	0	105	60	28	0	0	0	30

continued

Table IV. continued

		C			D			E	
Taxa	1	2	3	1	2	3	1	2	3
NEMATODES								2	2
WORMS									
Tubifex		5	6	8	2	6			2
Limnodrilus		5	8	219		213		3	3
Peloscolex						12			
SNAILS									
Campeloma								2	
Lymnaea									
Helisoma									
CLAMS									
Sphaeriidae									
AMPHIPODS									
Hyalella									
Gammarus	2								
ISOPODS									
Asellidae	2								
FISHFLIES									
Sialis	2								
CADDISFLIES									
Psychomyiidae	6								
Hydropsychidae									
MAYFLIES									
Heptagenia	2								
Ephemerella	3								
MIDGES		2	2	3	17	2	3	9	6
OTHER FLIES									
Culicoides							2	2	2
Tabanus									
Dixidae									
Tipulidae			2						
MITES									
Acari								2	
Total taxa	5	2	3	2	2	2	2	6	4
Individuals	17	12	18	224	19	233	5	20	15

continued

Table IV. continued

		F			G			H	
Taxa	1	2	3	1	2	3	1	2	3
NEMATODES						2			
WORMS									
Tubifex		5	2						
Limnodrilus	71	6		5					
Peloscolex		2							
SNAILS									
Campeloma									
Lymnaea				3					
Helisoma									
CLAMS									
Sphaeriidae									
AMPHIPODS									
Hyalella									
Gammarus									
ISOPODS									
Asellidae									
FISHFLIES									
Sialis						2			
CADDISFLIES									
Psychomyiidae							20	3	
Hydropsychidae									
MAYFLIES									
Heptagenia									
Ephemerella									
MIDGES	3	30	2	5	15	11	2		14
OTHER FLIES									
Culidoides		2					3	2	2
Tabanus		2							
Dixidae									
Tipulidae									
MITES									
Acari		2							
Total taxa	2	4	2	3	1	3	3	2	2
Individuals	5	110	12	13	15	15	25	5	16

continued

Table IV. continued

	J			K			L		
Taxa	1	2	3	1	2	3	1	2	3
NEMATODES									
WORMS									
Tubifex		2		2				2	2
Limnodrilus	5	2	2	27					
Peloscolex									
SNAILS									
Campeloma				14		2		3	2
Lymnaea									
Helisoma									
CLAMS									
Sphaeriidae									
AMPHIPODS									
Hyalella									
Gammarus									
ISOPODS									
Asellidae									
FISHFLIES									
Sialis									
CADDISFLIES									
Psychomyiidae									
Hydropsychidae									
MAYFLIES									
Heptagenia									
Ephemerella									
MIDGES	26	6	5	24	12	5	12	24	17
OTHER FLIES									
Culicoides		2							
Tabanus									
Dixidae									
Tipulidae									
MITES									
Acari		2					3		
Total taxa	2	4	2	3	1	2	2	3	3
Individuals	31	14	7	67	12	7	15	29	21